

Table showing for the month of May, &c.—Continued.

States and stations.	Rainfall of 10 inches, or more, per month.		Rainfall of 2.50 inches, or more, in 24 hours.			Rainfall equaling or exceeding one inch per hour.			
	Year.	Amt.	Year.	Day.	Amt.	Year.	Day.	Time.	Amt.
Wisconsin—Continued.		Inches.			Inches.				
La Crosse						1882	30	h. m.	Inches
Do.						1888	3	0.55	2.30
Milwaukee			1875	11	2.83	1878	23	0.15	1.04
Wyoming.								0.53	0.50
Cheyenne	1884	4.83							1.13

* Two distinct storms.

† Estimated.

The meteorological records of the Signal Service show that monthly rainfalls in excess of ten inches have occurred with greater frequency and over a larger part of the country during May than in the preceding months. The April records show that these monthly rainfalls have occurred at very few stations north of the thirty-fifth parallel, while the May records show that they have occurred locally throughout the northern part of the United States to the eastward of the Rocky Mountains, although a large majority of stations report no such rainfalls, and but few have recorded more than one since the beginning of observations. Eastern Texas and the Carolinas appear to have been most subjected to these excessive monthly rainfalls. On the Pacific coast and in the following-named states (some of which have several stations with long records) rainfalls reaching 10 inches, or more, have not been noted in May, viz., Indiana, Kentucky, New Jersey, Tennessee, Vermont, West Virginia, and Wisconsin. The rainfalls of May, 1887, on the north Pacific coast appear to have been the heaviest that have fallen in that region since the beginning of observations, but no station reports as much as ten inches, Tatoosh Island, Wash., reporting the maximum, 8.85 inches.

Daily rainfalls in excess of two and one-half inches have been much more frequent in May than in any month that has yet been considered since the discussion of these rainfalls was

begun in the REVIEW for October, 1887, and the area of the country subjected to same much more extended. In previous months these heavy daily rainfalls in districts to the eastward of the Rocky Mountains have been confined for the most part to the Southern States, but in the month of May they have occurred with nearly the same frequency in the upper Mississippi and lower Missouri valleys as in the Gulf States. In the lower lake region, New England, Kentucky, and Tennessee, and in portions of Virginia, West Virginia, Pennsylvania, and Ohio, very few daily rainfalls amounting to two and one-half inches have occurred during May in past years. The regions of greatest frequency of excessive daily and monthly rainfalls coincide.

While the number of stations reporting rainfalls of one inch, or more, per hour in May is somewhat greater than for previous months, the records at a majority of stations show that the heaviest rainfalls have not reached that amount. Portions of Iowa, Kansas, Nebraska, Pennsylvania, Tennessee, and eastern Texas appear to have been most subjected to excessive hourly rainfalls. Rainfalls exceeding a rate of one inch per hour have occurred in May four times since 1880 at each of the following-named stations: Wellsborough, Pa.; Chattanooga, Tenn.; Fort Riley, Kans.; 1.50 in twenty minutes (4.50 per hour) on May 14, 1885, at Fort Riley, being the maximum rate for these stations.

Of the heavy rainfalls shown by the records on file in the office of the Chief Signal Officer for the month of May the following are some of the most remarkable: Mobile, Ala., 1.64 in twenty minutes, on the 5th, 1879 (rate per hour, 4.92); Collinsville, Madison Co., Ill., 1.70 in twelve minutes, on the 23d, 1888 (rate per hour, 8.50); Fort McPherson, Lincoln Co. Nebr., 1.50 in five minutes, on 27th, 1868 (rate per hour, 18.00), and during another storm on the same date 2.25 fell in forty minutes; Emory Grove, Baltimore Co., Md., 5.00 in three hours, on 15th, 1879; Fort Snelling, Hennepin Co., Minn., 5.12 in two hours and twelve minutes, on 31st, 1877; Saint Matthew's, Orangeburg Co., S. C., 4.00 in four hours, on the 10th, 1888; Glenwood, Mills Co., Iowa, 6.00 in four hours, on 29th, 1878; Sedgwick, Harvey Co., Kans., 4.50 in two hours and fifty minutes, on 12th, 1877.

WINDS.

The most frequent directions of the wind during May, 1888, are shown on chart ii by arrows flying with the wind. The prevailing winds were from the north or northwest in the extreme Northwest and Missouri Valley; in the lower lake region and Gulf States they were mostly southerly; in the upper Mississippi valley, upper lake region, Atlantic coast districts, Rocky Mountain region, and on the Pacific coast there were variable.

HIGH WINDS (in miles per hour).

No maximum velocities of fifty or miles per hour, other than those given in the table of miscellaneous meteorological data, have been reported. The maximum velocity for the month, except at mountain stations, 80 miles per hour from the northeast, occurred at Corpus Christi, Tex., on the 28th.

LOCAL STORMS.

3d. A severe storm, accompanied by hail, passed north of Texarkana, Miller Co., Ark., during the evening, uprooting trees, etc. It is reported that crops were badly damaged and much stock killed. Reports from Camden, Ouachita Co., Ark., state that a violent storm passed through the eastern part of that county late in the afternoon, the path of the storm being about one hundred and fifty yards wide. Peru, La Salle Co., Ill.: a substantial bridge, about four hundred feet long, across the Illinois River, was wrecked by a severe storm in the evening.

6th. Kansas City, Mo.: reports from Harrisonville, Cass Co., state that one of the severest storms ever experienced occurred

in the southern part of that county. The growing grain was completely destroyed by hail in some portions of the county. The heavy rainfall caused Grand River to rise nine feet within two hours. At Kansas City the storm was of considerable severity, but no damage resulted.

7th. Springfield, Mo.: a thunder-storm, moving from southwest to northeast, began at 2.35 p. m., and was accompanied by heavy hail from 3.35 to 3.42 p. m.; fruit trees and garden vegetables were seriously injured.

9th. Centreville, Montgomery Co., Ohio: at 10 a. m. a tornado passed about two miles to the northwest, its path being about one hundred feet wide. No serious damage resulted. Abilene, Tex.: heavy rain and hail began at 6.10 p. m., the hail-stones being about the size of partridge eggs; at 6.25 p. m. another hail storm occurred, the hail-stones being unusually large, some measuring nine inches in circumference. Newark, Licking Co., Ohio: the southern part of this county was visited by a destructive hail storm on the night of the 9-10th.

10th. Cleveland, Ohio: severe local storms are reported to have occurred at several points in northern Ohio in the afternoon. At West View, Lorain Co., and New Philadelphia, Tuscarawas Co., the storms were of sufficient violence to blow down large trees and cause damage to buildings. Concordia, Kans.: thunder began at 11.55 p. m., and was immediately followed by a heavy fall of large hail, lasting two minutes; some of the hail-stones measured one and a half inches in diameter; many windows were broken and almost all tin roofs in this place were cut through by the hail; estimated damage \$2,000.

11th. Penn, Cass Co., Mich.: five miles west, considerable damage was done by a severe storm which occurred about 3.30 p. m. What appears to have been a well-defined tornado is reported to have occurred near Freeport, Stephenson Co., Ill., in the afternoon. The cloud was of the usual funnel shape, and moved in an easterly direction, destroying several buildings along Yellow Creek. Valparaiso, Porter Co., Ind.: forty freight cars were blown from the railroad track and many of them demolished by the storm which passed four miles east of this place during the evening. Bellvoir, Chatham Co., N. C.: severe thunder-storms, accompanied by hail, occurred on the 11th and 12th. The heavy rains caused streams to overflow, resulting in much damage.

12th. Bell Centre, Crawford Co., Wis.: about 5 p. m. a storm of great severity passed in a southeasterly direction from near the centre of the county for a distance of two miles, its path being about a half a mile wide. Three dwellings and many other buildings were destroyed, together with nearly all fencing and timber that lay in the storm's path. Some horses and cattle were killed and a number of persons were injured. Tionesta, Forest Co., Pa.: between 12.15 and 12.30 p. m. a storm prevailed, which unroofed several buildings; a small quantity of hail fell. Lexington, Va.: wheat and garden products were much damaged by the hail storm of the afternoon of the 12th.

17th. The Signal Service observer at Dodge City, Kans., reports the following:

It is learned from reliable sources that one of the severest hail storms for a number of years occurred between 4 and 5 p. m., about five miles north of station. The hail-stones varied in size from walnuts to hens' eggs, and after the storm the hail was from three to four inches deep. Large hail also fell at Cimarron, twenty miles west of here.

Pratt, Pratt Co., Kans.: during the night of the 17-18th a violent hail storm passed over this county. All windows of north and west exposure were broken, and small animals were killed by hail. At Cullison, in the same county, the hail broke through roofs of buildings, and large quantities of hail remained on the ground until the following morning.

19th. Durham, Durham Co., N. C.: a severe and destructive hail storm occurred in the afternoon, about ten miles northeast of Durham. The hail-stones are reported to have been nearly as large as hens' eggs.

20th. Opelousas, Saint Landry Parish, La.: the cotton crop in this vicinity was seriously damaged by a severe hail storm which prevailed for about one hour in the evening. In the southern part of the parish the storm was especially severe, and the cotton crop in that section was nearly ruined. The path of the storm was about three miles wide.

21st. Alexandria, Rapides Parish, La.: a hail storm of unusual severity passed near this place about 3 a. m. Four miles from Alexandria hail covered the ground to a depth of four inches. The course of the storm was from southwest to northeast. The observer at Fort Elliott reports that an unusually severe hail storm occurred twelve miles west of that place during the evening.

22d. Mesquite, Dallas Co., Tex.: one of most destructive hail storms that has ever visited this section appears to have developed about eight miles north of this place about 9 p. m.; hail-stones fell here as large as good sized apples, and being alternately round and flat in shape. The storm's path was from two to three miles wide, and its destruction to crops was very great; the greater portion of the cotton crop had to be replanted. Pine Mills, Wood Co., Tex.: a severe hail and rain storm passed over this place, destroying nearly all the crops. Wellington, Sumner Co., Kans.: the town of Argonia, about twenty miles west of Wellington, was visited by a severe local storm which destroyed a number of buildings. The wind velocity was estimated at seventy-five miles per hour, or more.

23d. Bonham, Faunin Co., Tex.: during the afternoon a destructive tornado occurred at Brookston, about twenty-five miles east of Bonham. The path of the storm was about three hundred yards wide, and within it all buildings, etc., were

demolished. The tornado was followed by heavy rain and hail. Sulphur Springs, Hopkins Co., Tex.: a destructive hail storm occurred two miles east of this place. The width of the storm's path was about three miles. Cotton plants were completely destroyed and corn was seriously injured. Corsicana, Tex., the storm which occurred during the night of the 23d-24th caused damage in this vicinity estimated at \$25,000. About a dozen small buildings were demolished and nearly all trees in the city were blown down.

24th. Knoxville, Johnson Co., Ark.: a violent storm, accompanied by hail, occurred during the early morning. The corn and cotton crops were badly damaged and many small buildings destroyed. Palestine, Tex.: a thunder-storm, accompanied by hail and very heavy rains, began at 11.35 and ended at 11.50 a. m.; some of the hail-stones were as large as hazel nuts; 1.17 inches of rain fell in fifteen minutes, doing much damage to railroads and farming interests in this vicinity. Vicksburg, Miss.: during a severe storm in the morning the court-house was partially unroofed and other damage done. Reports from Natchez state that the storm caused similar damage at that place.

25th. Hassan, Hancock Co., Ohio: heavy rains caused streams to rise to greater heights than have been known for many years. Athens, Jewell Co., Kans.: about 8 p. m. a violent storm of hail, rain, and wind passed over this place, causing considerable damage to buildings and crops. Boise City, Idaho: a very destructive hail storm is reported to have occurred at Willow Creek, fifteen miles northwest of this city.

The Signal Service observer at Fort Elliott, Tex., reports:

A thunder-storm began at 4.10 p. m. and ended at 7.40 p. m., moving from southwest to northeast. Hail began at 5.18 p. m. and ended at 5.26 p. m., the hail-stones being spheroidal in shape and about two inches in diameter; formation, solid snow. The "breaks" (hills) at the foot of the plains, seven miles northwest of station, were absolutely white with hail-stones for three hours after the storm. This was observed by everybody at the station; on the morning of the 26th I walked down to the Sweetwater Creek, three-fourths of a mile distant, and saw great banks of hail-stones which had been washed down during the night. The bottoms along the Sweetwater were literally covered with banks of hail-stones from six to eight feet in depth. It was estimated that there was enough hail to cover ten acres to a depth of six feet. The hail-stones killed five horses which were out on the prairie, on a ranch six miles north of station. The Sweetwater Creek was higher than ever known before, the freshet destroying nearly the entire post garden. The high water is supposed to have been caused by a "cloud-burst" at or near the foot of the plains, where the Sweetwater has its source; there was only 0.36 inch of rainfall at the station. On Sunday, May 27th, hail-stones were collected on the banks of the Sweetwater, which had been washed down and lay in drifts six feet deep, actual measurement by the observer.

26th. Fort Reno, Ind. T.: it is reported that a tornado occurred at Silver City, twenty-five miles southeast of here, at 3.30 p. m. Several out-buildings were destroyed, and twenty-five head of cattle killed. Manhattan, Riley Co., Kans.: a rain and hail storm occurred during the afternoon, one inch of rain falling between 5.30 and 6 p. m. Fifteen miles northwest of Manhattan wheat, oats, etc., were destroyed. The storm was also very severe and destructive in Clay and Cloud counties, lying northwest of Riley county. Cedarville, Crawford Co., Ark.: a tornado occurred in the Indian Territory, ten miles northwest of this place, at about 7 p. m. It moved in a direction to the north of east, the width of its path being about one-fourth of a mile and the length about twelve miles. The storm passed through a heavily timbered region, destroying nearly all timber in its course. Evansville, Washington Co., Ark.: was in the path of the storm and, at that place, two dwellings were demolished and several buildings unroofed. Wakefield, Clay Co., Kans.: a severe rain and hail storm began at 4.25 a. m.; a large quantity of hail fell, some of the stones being as large as hens' eggs; much damage was done to small fruits, vegetables, etc., in the path of the storm. Chadron, Dawes Co., Nebr.: a "cloud-burst" occurred in the northwestern part of this county during the night of the 26-27th, submerging five miles of railroad track and washing out numerous bridges. White River rose six feet in less than an hour.

27th. Indianapolis, Ind.: a severe thunder-storm prevailed from 6 to 9.25 a. m.; heavy rain fell from 8.20 to 9.35 a. m.

during which time 1.25 inches of rain fell. Hail fell for five minutes, the hail-stones measuring one-quarter of an inch in diameter; in the outskirts of the city the hail was of much larger size. Hillsborough, Hill Co., Tex.: a large number of buildings were wrecked or damaged by a tornado which occurred here at 7 a. m. The damage is estimated at \$100,000. Davenport, Iowa: the rain and hail storm in the afternoon caused damage in this vicinity to buildings, crops, etc., estimated at \$50,000 or \$60,000. The storm began at 3 o'clock and continued for about twenty minutes. Elgin, Kane Co., Ill.: at 5.30 p. m. a destructive hail storm occurred. The hail-stones were of remarkable size and broke large quantities of window glass. Reports from Galesburg, Knox Co., state a hail storm occurred at that place also. Memphis, Tenn.: the storm on the night of the 27-28th caused no damage at this place, but reports show that it was very destructive in other parts of the state. Reports from Holly Springs, Miss., state that the storm was unusually severe in that vicinity. Des Moines, Iowa: during the night of the 27-28th South Des Moines, Sevastopol, and Bloomfield townships were visited by a very destructive storm. Hail fell in large quantities, some of the hail-stones being unusually large.

28th. Chambersburg, Franklin Co., Pa.: about 4 p. m. a terrific hail storm passed over this place. The hail-stones were unusually large and of irregular shapes. Large quantities of window glass were destroyed, and persons and animals were seriously cut and bruised by the falling hail. Canton, Stark Co., Ohio: at about noon a severe storm passed over this place, causing damage estimated at \$60,000, \$50,000 of this amount being sustained by the New Hampden watch factory, the south wing of which was destroyed. Savona, Steuben Co., N. Y.: about 5 p. m. severe and destructive local storms occurred in this and neighboring counties. Reports from Cameron Mills, in Steuben Co., Wellsville, Alleghany Co., Olean, Cattaraugus Co., and Elmira, Chemung Co., show that storms of unusual severity occurred at those places, causing damage to a greater or less extent. The "New York World" of the 29th states that twenty business blocks at Waterville were unroofed, and that a church and several other buildings at Allentown, Alleghany Co. were wrecked. Wheeling, West Va.: severe local storms occurred in this part of the state, and in some places they were accompanied by hail. Much damage

was done by lightning. Cadiz, Harrison Co., Ohio: a storm of great severity prevailed at this place in the afternoon, causing damage to many buildings. Eden, Erie Co., N. Y.: about 7 p. m. a hail storm occurred here, the hail-stones being of considerable size; the storm was about of twenty minutes duration. Oil City, Pa.: a violent and destructive storm occurred here at between 2.30 and 3 p. m. Remarkably severe storms also occurred at other points in this and neighboring counties, and, in some instances, the characteristics of tornadoes were apparent. In the vicinity of Clintonville, Venango Co., numerous derricks and out-houses were blown down. Similar damage was also done at Fern and vicinity, in Clarion Co., and at Titusville, Crawford Co. Zanesville, Muskingum Co., Ohio: the storm which passed over this section in the morning was of unusual severity. At Gaysport three spans of a new bridge were carried away.

31st. Cartwright's Wharf, Nansemond Co., Va.: about 4 p. m. a storm passed over this place, moving in a northeasterly direction, blowing down many trees and causing damage to buildings.

WATER-SPOUTS.

Capt. C. H. Hossack, of the s. s. "Saint Asaph," reports: "May 1st, 5 p. m., in N. 27° 52', W. 79° 41', observed one large and six small water-spouts; the former appeared large at the clouds and got gradually smaller as it neared the surface of the sea, where it ended in a long curve from ne. to sw. On looking at it with glass, it seemed spiral in shape and travelling from e. to w.; although only about one mile distant, could see no ascending currents. The smaller spouts appeared to be within one-eighth of a mile of each other and distant about seven miles from the ship. They seemed large at the clouds, decreasing in size toward the centre, and increasing at the base, and were travelling from e. to w. Barometer and thermometer steady, no fluctuation in either observable."

Capt. J. W. Tobin, of the s. s. "Alps," reports: "Near Jamaica, W. I., May 10th, between 4 and 5 p. m. (Greenwich time) observed eight or ten water-spouts to the westward; at 5 p. m. was struck by a heavy squall of rain, with wind-force about 9, from se., lasting three hours, after which dirty weather continued until we were well to the northward of the Bahama Banks. There was no notable change in the barometer."

INLAND NAVIGATION.

OPENING OF NAVIGATION—ICE IN RIVERS AND HARBORS.

Strait of Macinac.—Saint Ignace, Macinac Co., Mich.: on the 1st there were from twenty to thirty ice-bound vessels between Waughoshance Light and Saint Helena's Island. The ice in the strait broke during the 4th and a large fleet passed through. The following table, showing the dates of the opening of Mackinac Strait for each season since 1854, is from the "Chicago Inter-Ocean" of May 5, 1888:

Year.	Date.	Year.	Date.
1854	April 25	1872	April 28
1855	May 1	1873	May 1
1856	May 2	1874	April 29
1857	May 1	1875	April 28
1858	April 6	1876	April 20
1859	April 4	1877	Mar. 14
1860	April 13	1878	April 23
1861	April 25	1879	April 5
1862	April 18	1880	May 3
1863	April 17	1881	April 4
1864	April 23	1882	April 5
1865	April 21	1883	April 28
1866	April 29	1884	April 28
1867	April 23	1885	May 6
1868	April 19	1886	April 21
1869	April 23	1887	April 23
1870	April 18	1888	May 4
1871	April 3		

The remarkably early opening of 1878 (March 14) was seven weeks in advance of the present season.

Lake Erie.—Buffalo, N. Y.: floating ice on the 1st; lake full of ice on 10th.

Lake Michigan.—Milwaukee, Wis.: the ice in the strait of Macinac broke up on the 3d, and vessels on both sides passed through. The steamer "Oswego" reached this point at 11 p. m., being the first arrival of the season from the lower lakes.

Green Bay.—Green Bay, Wis.: the steamer "Welcome" which cleared on the 2d was the first departure of the season; the first arrivals were the steamers "Middlesex" and "De Pere," on the 4th.

Lake Superior.—Duluth, Minn.: the steam barge "Kosato," from Buffalo, N. Y., arrived on the 12th, and the propeller "Freemont" cleared on same date. There was much broken ice in the lake on the 22d, rendering navigation dangerous.

Marquette, Mich.: the harbor was cleared of ice by a strong westerly wind during the night of the 4-5th. The steamer "Toledo" arrived on the 11th, being the first boat of the season.

Devil's Lake.—Fort Totten, Dak.: the ice in the lake broke during the morning of the 10th, and by 9 a. m. had entirely disappeared. Steamer "Minnie H." made her first trip this season on the 11th.

Missouri River.—Poplar River, Mont.: the steamer "Batchelor" arrived on 25th, being the first arrival of the season.

STAGE OF WATER IN RIVERS AND HARBORS.

In the following table are shown the danger-points at the